SCIENCE

FRIDAY, OCTOBER 22, 1915

CONTENTS

Applied Chemistry: DR. L. H. BAEKELAND.. 547

Doctorates conferred by American Universities. 555

The Trustees of the University of Pennsylvania on Academic Freedom 565

Scientific Notes and News 566

University and Educational News 569

Discussion and Correspondence:—

Parasites of the Muskrat: DR. FRANKLIN D. BARKER. *The Chemical Composition of Bornite:* DR. EDGAR T. WHERRY. *Wind Gaps:* PROFESSOR ARTHUR M. MILLER. 570

Scientific Books:—

Rosenthaler's Der Nachweiss organischer Verbindungen: DR. ROSS AIKEN GORTNER. *Turner on Molecular Association:* PROFESSOR LOUIS KAHLENBERG 573

Special Articles:—

On the Coefficient of Correlation as a Measure of Relationship: PROFESSOR CHARLES N. MOORE. *An Aberrant Ecological Form of Unio complanatus Dillwyn:* STEPHEN G. RICH 575

The American Phytopathological Society: DR. C. L. SHEAR 580

The American Association for the Advancement of Science:—

Section B, Physics: DR. W. J. HUMPHREYS. 584

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

APPLIED CHEMISTRY[1]

IT is only three years ago that a Brooklyn alderman, who, in the absence of the mayor of New York, had to welcome the visitors to the International Congress of Chemistry, addressed them as if they were druggists or pharmacists.

After all, he made not a much greater mistake than many so-called educated men who obtained a B.A. and yet are ignorant enough of elementary scientific knowledge to imagine that the main occupation of a chemist is to analyze substances and detect falsifications.

Even in England, a pharmacist is currently designated as "chemist," while a real chemist is called an "analytical chemist."

But the European war has done much to correct some of these mistaken notions of the public at large. Our daily press has now more or less acquainted this country with the fact that in our national make-up there is such a thing as chemical problems. I doubt, however, whether the unthinking masses have begun to realize that aside of the so-called chemical industry, practically every other industry, in fact, every enterprise, has chemical questions to contend with, and that chemical industry itself is intimately interwoven with the great network of every modern industrial or agricultural state; that the economic welfare of our country and the health of its citizens are largely dependent on the way we utilize our chemical knowledge.

The present war has been aptly called a "chemical war," because efficient work of

[1] An address presented at the meeting of the American Chemical Society, Seattle, Wash.

every department of the fighting armies, from the Red Cross service to the manufacture of guns and explosives, involves incessantly chemical knowledge and—still more chemical knowledge.

But do not imagine that this is the first chemical war: The art of killing and robbing each other became "chemical" the day gunpowder was invented; at that time, however, the existing knowledge of chemistry was just of pinhead size. Napoleon knew very well how to use adroitly exact knowledge and chemistry for furthering his insatiable ambition to dominate the world; so he surrounded himself with the most able chemical advisers and scientists, and, for a while at least, he placed himself at a decided advantage over his many enemies; incidentally, he thus helped to lay the foundation for some very important branches of chemical industry.

"Les chiens ont appris quelquechose," exclaimed the Corsican conqueror when he realized that his enemies began to adopt the same means which had given him temporary mastership over them; but those whom he called so contemptuously "the dogs" finally beat him at his own game.

Ever since then, science, technology and chemistry in particular have played a rôle of increasing importance in the armament of nations. This accounts perhaps for the strange fact that the really great military inventions have practically all emanated from civilians and from non-military nations like our own. If the men of the military class, essentially conservative in all countries, had been left to their own devices, they would probably still be fighting with bows and arrows, or perhaps with the traditional sling. Nor should the pacifist blame the chemist if the latter's most beautiful conquests in science, if his proudest discoveries, have been turned into means of relentless destruction and human slaughter. Do not reproach chemistry with the fact that nitrocellulose, of which the first application was to heal wounds and to advance the art of photography, was stolen away from these ultra-pacific purposes for making smokeless powder and for loading torpedoes. Do not curse the chemist when phenol, which revolutionized surgery, turned from a blessing to humanity into a fearful explosive, after it had been discovered that nitration changes it into picric acid.

As well might you curse written speech or language or the art of printing—by which the most noble thoughts of the human race have been expressed, disseminated and preserved—if it has been used also to distribute the vilest lies and the most damnable errors.

Knowledge is like a knife. In the hands of a well-balanced adult it is an instrument for good of inestimable value; but in the hands of a child, an idiot, a criminal, a drunkard or an insane man, it may cause havoc, misery, suffering and crime.

Science and religion have this in common, that their noble aims, their power for good, have often, with wrong men, deteriorated into a boomerang to the human race. Our very successes will threaten to devour us as long as all of us have not yet become imbued with the truth that greater knowledge, like greater possession of wealth or power, demands a greater feeling of responsibility, greater virtues, higher aims, better men.

Let us hope, in the meantime, that war carried to its modern logical gruesomeness, shorn of all its false glamor, deceptive picturesqueness and rhetorical bombast, exposed in all the nakedness of its nasty horrors, may hurry along the day when we shall be compelled to accept means for avoiding its repetition.

Would you take it amiss if I made a digression from my subject as an answer to repeated attacks which have been made of late by some shortsighted men who blame our increasing scientific knowledge in general and our chemical science in particular, for the excesses of the present European war?

But let us turn our attention to more peaceful chemical pursuits and more particularly to the chemists of this country.

Their work is difficult to understand and still more difficult to be appreciated by the uneducated or uninitiated; nor do chemists court the plaudits of an ignorant public that can not understand them; they feel fully compensated by the results of their work if it only meets with the approval of a few of their fellow chemists, irrespective whether it brings them financial results or not; in fact, most chemists are so much in love with their work that very often they neglect the financial side, to their own immediate detriment.

Unlike the physician, lawyer, clergyman, actor, writer, artist or business man, the chemist does not depend on the public at large; he is either engaged in some private enterprise or he acts in a consulting capacity for a few people, or he is teaching in some educational institution. Popularity in the usual sense has little or no value for the chemist.

No wonder then that the chemists of this country, numerous and active as they are, have hardly been noticed among the daily noise of newspaper sensation and shrieking publicity—no more than a skillful watchmaker would be noticed among the hammering of a busy steam-boiler-manufacturing plant.

And yet, right here in the United States, the chemical profession has taken such a root, such a development during the later years, that our national American Chemical Society, which counts over 7,000 members, has by far the largest membership of any chemical society in the world, with all due respect to England, France and Germany; a society which finds it possible to spend yearly over $100,000 on its three chemical publications, copies of which are to be found all over the world in every well-equipped scientific library. Nor is the study of chemistry in this country a matter of recent occurrence. Our European friends are astonished when we tell them that as far back as 1792, there existed already the Chemical Society of Philadelphia, which was probably the first chemical society ever organized in the world; some of the papers presented at the meetings of that early scientific body furnish even today very interesting reading. Some of our American educational institutions equipped chemical laboratories for students at a time when exceedingly few of the best-known universities possessed any such facilities. In fact, the Rensselaer Polytechnic Institute of Troy, New York, established a chemical laboratory at about the same time as was founded the famous laboratory of Liebig, at the University of Giessen, 1825, and the movement for the establishment of laboratories in the United States was independent of that in Europe.

Nor should we overlook the fact that notwithstanding the essentially pragmatic tendencies of our country, the United States has given to the world a Willard Gibbs, who out-theorized existing chemical theories and whose mathematical deductions are still, after his death, furnishing food for profound thought to the most renowned physical chemists of Europe to whom they have opened entirely new fields in the study of chemical dynamics.

I mention this more particularly for the reason that our aniline-dye-consumers have taken the chemists of the United States

bitterly to task and have made decidedly unfavorable comments upon their abilities, because, since the European war, dyes could no longer be imported from Europe. But Dr. B. C. Hesse, an American-born chemist, a graduate of the University of Michigan, has already ably answered this indictment of the American chemists. In a paper full of information on this subject, which he presented at the New Orleans meeting of the American Chemical Society,[2] but which, unfortunately, has received little or no attention from our daily press, he has clearly demonstrated that the aniline-dye-consumers of the United States can have all the chemists and all the dyes they want; provided they are willing to make the necessary investments of capital and to submit to the risk of uncertain profits by starting their own dye-manufacturing establishments here in the United States instead of, as in the past, favoring imported dyes, either through personal prejudice, or by fostering legislation which forbids the home manufacturers to utilize such methods of selling agreements as "Kartels" or other consolidations of interests; or "dumping," so as to kill new competitors in the field, while making up the temporary loss by increasing the price of other products, and, in general, any of the many other trade-arrangements and trading tricks freely and openly utilized by European manufacturers so as to stifle possible competition of our home aniline-dye-producers.

The outcry which has been raised as to our shortage of artificial dyes is out of all proportion if we take in consideration that the annual importation of dyes and synthetic products from Germany amounts only to about $9,000,000. Mr. A. D. Little, a former president of the American Chemical Society, pointed out[3] that this represents about the same money value as the amount of candy sold annually by the Woolworth ten-cent stores.

The development of any chemical industry is a matter of local opportunities; for instance, the manufacture of cellulose, as well as the industry of wood-distilling, has taken a greater development in the wood-covered sections of the United States than in Germany or any other country in the world.

The magnitude and earning capacity of the largest German chemical enterprises, however imposing they may be, look less important if you take into consideration that some of these companies have been in existence for more than half a century. Much younger American chemical enterprises, which make American specialties—for instance, the Eastman Kodak Company, which sends its films and photographic papers throughout the world—have annual earnings decidedly greater than the most successful German chemical works of much older existence. Nor is the value of the output of some of our largest purely chemical companies much less important than that of the German concerns.

This country is now the greatest producer of sulphuric acid, with an annual production of about 3,000,000 tons. Yet it is not so long ago that the first maker of sulphuric acid had trouble to find purchasers for a triflingly small production of a few tons per week. It needed the opportunity of a home market; by and by this market was created through the refining processes of petroleum after the discovery of our oil fields; the discovery of natural phosphates and the resultant industry of superphosphates; the use of dynamite for blasting; the development of the glucose

[2] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 4, April, 1915, p. 293.

[3] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 3, March, 1915, p. 237.

industry, electrolytic copper refining, etc. These and many newer industries all required large amounts of sulphuric acid and gave this country an opportunity of developing sulphuric-acid manufacturing to its present magnitude. In fact, the same reasoning holds good for all of our industries. I doubt very much whether the talented foreigners, who have now become famous in chemical manufacturing, would have tied their initiative and enterprise by specializing in coal-tar-dyes manufacturing, if they had had the limitless opportunities of an immense undeveloped country like ours, to which to give other outlets to their spirit of pioneership, mining, transportation, agriculture and similar subjects, all beckoning for more urgent attention, and offering at the same time more immediate rewards.

In the meantime some of our other chemical industries, better suited to our local conditions, have taken such an enormous development here as to make the United States an undisputed leader in at least some of them. Such products as the various acids and salts, aluminum, artificial abrasives, calcium-carbide, soda and caustic alkalies, bleaching powder, chlorine products, electrolytic copper, are decidedly more imposing in value and in economic importance than the few million imported coal-tar-dyes.

Mr. F. A. Lidbury, of Niagara Falls,[4] pointed out rightly that if there had been a shortage in some of the products of our electrochemical industries in which the United States has been a pioneer, the consequences to our national economics would have been so serious that the present complaint of our aniline-dye-users would have sounded like a timid whisper, compared with the bellowing lamentations of so many more important industries which would have become absolutely paralyzed. The fact is that few men realize how many industries are directly dependent on the work of American chemists. If the aniline-dye industry has been neglected in this country, there are many good reasons for it; not only was the possibility of reasonable profits too scant to offer special inducement to clever-headed business men for risking their capital in this branch of manufacturing when they had so much better choice in other channels of enterprise, but the first raw material, suitable coal-tar, was not abundantly available here as it is in Europe, for the simple reason that this country long ago discarded the older and more expensive methods of gas manufacturing still generally used in Europe, and which give coal-tar as a by-product. The less expensive and simpler water-gas process, adopted in the United States, gives no suitable gas-tar; it is only of late, by the introduction of the by-product coke-ovens, that we can look forward to an almost illimited supply of coal-tar.

In the meantime, the German manufacturers, while possessing every opportunity and inducement for specializing in these coal-tar industries, could afford to concentrate their efforts so as to supply not only their home consumption and that of the United States, but that of the whole world, in about the same way as the United States sends to the remotest corners of the globe its sewing machines, its typewriters and its Ford cars.

Judging from the past history of the chemical industry in America, I have little doubt that the day it will be found profitable to manufacture all kinds of synthetic dyes here in the United States, instead of a few as is the case now, there will be little further delay in supplying the demand by a hustling and bustling home production.

[4] See *Metallurgical and Chemical Engineering*, Vol. XIII., No. 5, 1915, p. 277.

In fact, it is quite possible that under the present conditions this branch of manufacturing may be stimulated to the point as to result in over-production after the war is over.

If hitherto our chemists have been deficient in this special line, we can, with some satisfaction, point to better efforts in other chemical industries. For instance, it is not sufficiently known how many research chemists in our different American manufacturing establishments are busily occupied in studying and improving manufacturing processes, nor what large sums of money are devoted every year to industrial chemical research. If we hear it constantly repeated that some of the largest German chemical companies have hundreds of chemists and engineers, it is less known that right here in the United States the number of chemists employed in some of our better organized chemical enterprises is scarcely less; but nobody finds it necessary to boast about it. In fact, the most striking symptom is that so many engineering enterprises, for instance, some of our large electrical companies—although their field of action seems rather remote from chemical subjects—have now elaborate chemical research organizations with an excellent record.

Conditions were quite different some fifteen or twenty years ago; but this country has grown, and as the requirements and opportunities grew up new chemical problems arose thereby.

The urgent nature as well as the magnitude of some of these new chemical problems is shaking our chemists awake—is making new men of them.

Professor Whitaker is probably right when he says that from the standpoint of efficiency the chemists are thirty years behind the engineers as far as method and attitude of mind are concerned, but this same criticism holds good for chemists all over the world. The fact is that the engineer was called first, and he was born centuries before the chemist, but the latter is now making up for lost time.

New conditions, new problems, are compelling the chemist to learn to tackle a proposition in a true engineering spirit and —to hitch some business sense to it. He is learning to forget thinking or acting on the test-tube plan; he is thrown more and more in contact with business men; he begins to realize that too one-sided theoretical considerations are sometimes more dangerous than complete ignorance and that a sense of proportion and relative values is the first requirement for good practical effort.

Here, indeed, is one of the weakest spots of the chemist. Aside from the fact that the chemical profession seems one of those vocations which have fascinated a large number of intellectual freaks, it has generally attracted men of an analytical rather than a constructive turn of mind. Successful engineering is essentially constructive. The most urgent work for the chemist of to-day must be constructive—he must learn how to cement together the vast amount of data which already lie at his disposal, even if he himself has to provide some of this very cement by further research.

The chemist of to-day is no longer confined to purely chemical enterprises; even the most stubbornly conservative manufacturers have learned, through competition, that every industry, however mechanical be its nature, has its chemical problems. Things have changed rapidly since the day Andrew Carnegie listened with a sly twinkle in his eyes to the fun his competitors were poking at him when he first engaged a spectacled professor to investigate the chemical problems in his iron-works. Conditions have now become reversed; to-day, a steel or iron works without a com-

petent chemist justly provokes contempt and distrust.

Nor is the time so far distant when even our biggest railroads had not begun to realize how they missed the constant services of a staff of chemists, so as to advise them in the various chemical problems which present themselves in the operation of a well-organized railroad system.

Some time ago, I visited the plant of the National Cash Register Company, in Dayton, Ohio; one of its most interesting departments was its well-equipped chemical laboratory, where no end of chemical questions relating to the manufacture of purely mechanical devices have to be studied and solved. No up-to-date motor-car works is complete without its chemical department and the same remark holds good for all well-organized engineering concerns.

In the United States, the importance of chemistry has been appreciated first in its relation to agriculture. So obvious was this, that we set an example to all other nations of the world by the number and extent of our federal and our state chemical agricultural laboratories. This, more than anything else, was the entering wedge of applied chemistry in this country, which extended, later on, to the government service, the Geological Survey, the Bureau of Standards and the Bureau of Mines. Nor did the useful effect stop there. Many of our federal chemists, our state chemists, have left public service, to accept better paying positions in private industries; but these men trained in public service, implanted their high aims and scientific ways in some of our commercial enterprises, which needed it badly. I know of some cases where this beneficial influence changed radically the whole tone of the commercial organization, from its manufacturing to its selling department, and introduced, instead of reckless, sordid commercialism, a spirit of fairness and efficiency which soon proved the more profitable policy.

In this and similar directions the chemist can exercise a valuable moral influence on the community. If you think it over, you will find that the quest for efficiency lies close to the path of honesty, justice and equity.

Here also the chemist has much to learn. In some instances, I have been astounded at the almost childlike attitude of mind of some of our chemists who are too ready to sell their services to anybody who has a temporary use for them, irrespective of the underlying motives or purposes.

Some lawyers tell me that they never have the slightest difficulty in hiring chemical experts to defend contradictory opinions. For instance, it is quite amazing how some chemists, in their eagerness to please their employers, will overlook their own ignorance of the most elementary principles of patent law, as well as their superficial acquaintance with the many details of intricate technical questions, while not hesitating to furnish cock-sure opinions which encourage infringers or industrial pirates to trespass on the rights of intellectual property of others. Much ruinous patent litigation would be avoided in this country, and invention would be better encouraged, if we had more men of the type of that well-known British electrical expert who never hesitates in court to tell the simple and direct truth, regardless whether it kills or saves the case of his client; his statements are so highly valued and respected that the judges accept them without suspicion, and the same expert is frequently retained by the two opposing parties, whom he serves impartially, and who gladly pay him higher fees than to a mere litigation-acrobat-expert, or a chemical "ambulance-chaser."

The ethics of our profession have been

dealt with by the American Institute of Chemical Engineers, and have been embodied in its recently adopted Code of Ethics, which may furnish a good guide for younger or less experienced chemists. And this leads me to state that many more manufacturers or business men would be induced to utilize the services of chemists if they could feel confident that in so doing they are not putting themselves at the immediate mercy of a stranger, by confiding to him unreservedly facts or processes which it has cost them many sacrifices of time and money to accumulate, and the undivided knowledge of which constitutes sometimes one of their most valuable assets. On the other hand, a chemist can hardly be of any service unless his client or employer is just as frank with him as he would be with his lawyer or physician. However, this mooted point is easily overcome by referring to the Code of Ethics to which I have just alluded, or, better, by making a preliminary agreement between the chemist and his client or employer, safeguarding the interests of both parties. But in such a case, the compensation to the chemist should be made commensurate to the occasion.

This same principle holds good in the employment of chemists in manufacturing plants, where the chemist is either engaged in research or in a manufacturing capacity. An employer should not expect an intelligent chemist to render him important services without proper compensation, and in as far as the practical value of the work of a chemist can seldom be determined in advance, it will pay the employer to offer special inducements or rewards for initiative; he can well afford to give his chemist some share of the increased profits he has received through his work; to do otherwise would be narrow-minded, short-sighted and detrimental to the direct interests of the employer. The work of a research chemist can not be performed nor measured like that of a bookkeeper or a laborer; the results of his work are uncertain; delays and obstacles beset him at every turn; sometimes luck plays an important rôle; but good will, enthusiasm and persistent endeavor are indispensable factors, and these may be encouraged or killed by the attitude of the employer. An employer who is unfair, or who can not arouse the respect or the enthusiasm of his chemists, can not get the best there is in them; he must make them feel that if their work turns out well for him, they will get some fair share of compensation. Therefore, a reasonable salary ought to be supplemented by the possibility of a bonus or some share in the profits based on earnings brought about directly by the work of the chemist.

On the other hand, the chemist must not overlook the financial sacrifices and business-risks assumed by his employer. He should specially bear in mind that knowledge or experience gathered at great cost by his employer, or through expensive factory equipment, or other special facilities, have in most cases enabled him to take up his own part of the work at an advanced stage. It would be rather unfair, unless otherwise stated, that a chemist should be allowed, during or after his period of employment, to divulge or take advantage of all the confidential knowledge or information gathered around the works in which he is employed; or patent for his exclusive benefit any invention he may make on those particular subjects for which he is engaged, as long as the stimulating ideas themselves have been gathered by the very means put at his disposal by his employer. All these questions should be provided for and embodied in an equitable contract which will necessarily vary with special circumstances. But here again, niggardliness, or too great cunning-

ness of the employer, will hardly pay. Unless his chemist be a fool—and a fool of a chemist is not worth anything—his employer will lose the good will and confidence of the very man whose work is primarily dependent on these indispensable factors.

Faithful and generous observance of these conditions has brought about the most excellent results in many instances; I know that the contract system, with a salary supplemented by a bonus, or some participation in profits in special departments, has been used with great advantage to all concerned, by some of the most successful chemical companies in continental Europe and in some of the more progressive American enterprises.

It has been objected that a contract of the kind merely binds the employer who has tangible assets, while in most cases it would be difficult to enforce it against faithless employees possessing no property. But even then, a clear and well-defined contract will prevent many misunderstandings which may crop up in the course of time. It has been my experience that direct dishonesty and faithlessness are merely exceptions among chemists, whatever their other shortcomings may be.

We know where the work of the chemist begins. We can never tell where it ends and through what unexpected ramifications it may lead. It is just this fact which adds some zest to the life of the struggling, hard-working chemist, and brings to his work frequently as much excitement as the best of sports; his hopes and disappointments can be compared to those of the restless prospector.

Pasteur, while he was professor at the University of Lille, was consulted by a local alcohol distiller about some irregularities in the fermentation processes. Little did the great French chemist dream, when he tried to solve this seemingly trifling industrial problem, that by doing so he was going to lay bare such an amount of new and unsuspected scientific facts destined to upset all formerly accepted notions, not merely on fermentation, but on life, disease, contagion and epidemics; that he was about to revolutionize surgery, sanitation and medicine, and create several new departments of medical science; that he was going to save millions of lives—reduce sorrow and misery. So little were the men of that period prepared for all these stupendous revelations that this great benefactor of the human race had to suffer most from the gibes and violent attacks of some of the best known men of that very medical profession into which he was going to infuse new life by placing it on a true scientific basis. The history of the stubborn polemics and angry discussions at the French Academy show that, at that time at least, the imagination even of men of science, could not expand to the point of perceiving that medicine and surgery were to be remodeled by a mere chemist.

L. H. BAEKELAND

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

THERE were last year conferred 556 degrees of doctor of philosophy or science by institutions competent to confer these degrees. This number exceeds the number for last year by 10 per cent., and is double the average number for the decennium beginning in 1898, when these records were begun. During that decennium seven institutions conferred 2,045 degrees and the remaining 38 institutions 685 degrees. The seven institutions still lead decisively, but not to the same extent, and their grouping has been altered. In the first period, Chicago, Harvard, Columbia, Yale and Johns Hopkins each conferred an average of over 30 degrees, while the number at Pennsylvania and Cornell was in the neighborhood of 20. In the course of later years Columbia has surpassed Chicago, and Harvard has not kept equal with these two universities. Yale and Johns Hopkins have remained about stationary